Pesticide Knowledge and Risk Perception Among Adolescent Latino Farmworkers

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Abstract

A substantial proportion of the agricultural production in the U.S. is dependent on the labor of Latino farmworkers. While exact figures are not known, it is estimated that adolescents make up 7% of this valuable workforce. These young workers may be at increased risk for the toxic effects of environmental exposures encountered during their work. Furthermore, language barriers and health beliefs may influence the risk perceptions of this population.

We conducted a cross–sectional survey of migrant adolescent farmworkers in 1998 to investigate their work practices, health beliefs, and pesticide knowledge. The large majority of the adolescents in our sample were from Mexico, and 36.3% spoke primarily indigenous languages. Many of the adolescents (64.7%) were traveling and working in the U.S. independent of their parents. Few of the adolescents reported having received pesticide training; however, 21.6% of the sample reported that their current work involved mixing and/or applying agricultural chemicals. The scores on the pesticide knowledge questionnaire were found to significantly predict self–reported use of protection for adolescent farmworkers.

The results of this study point to a need for improved pesticide training in youth agricultural workers and specialized education efforts directed toward minorities who speak indigenous dialects. Special attention is merited toward adolescent farmworkers who report that their work includes mixing or applying agricultural chemicals. As the number of adolescent farmworkers increases in the U.S. and the characteristics of the migrant stream continue to change, culturally and developmentally appropriate instruments are needed to adequately assess the health beliefs and protective practices of this population.

Keywords. *Pesticides, Adolescent workers, Health beliefs, Occupational health, Agricultural workers.*

Agriculture in the U.S. is highly dependent on the labor of seasonal and migrant Latino farmworkers. In recent years, the proportion of youth working in agriculture in the U.S. has received heightened attention (Kissam et al., 2001; NRDC, 1998; U.S. Department of Labor, 2000; U.S. GAO, 1998b). Although there

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are no comprehensive statistics that encompass the total number of children working in agriculture, the results of the National Agricultural Workers Survey, conducted by the U.S. Department of Labor in 1997–1998, indicate a trend toward an increased percentage of hired farmworkers between ages 14 and 17 (U.S. Department of Labor, 2000). Recent estimates indicate that about 129,000 hired farmworkers ages 14 to 17 work in crops, but these estimates exclude youth under age 14. Even with the limitations inherent in the National Agricultural Workers Survey (such as including only crop farmworkers, excluding unpaid family workers, age limitations, and small sample size), it is estimated that the 14 to 17 age group now makes up 7% of all hired farmworkers (U.S. GAO, 1998b).

It has been suggested that adolescents may be vulnerable to toxic environmental exposures due in part to their stage of development (Golub, 2000). The biology of adolescence is distinctive and provides opportunities for unique actions of toxic substances to disrupt both maturation and function. Given this developmental vulnerability, current agricultural safety and health training and the protective standards for youth workers may not be adequate (Quandt et al., 1999; Shu et al., 1988). The U.S. Environmental Protection Agency (EPA) is responsible for protecting agricultural workers from pesticide exposure. However, the Worker Protection Standard does not distinguish children from other workers (U.S. GAO, 1998a).

Protection practices and training designed for adults may not be adequate for an adolescent population (Committee on the Health and Safety Implications of Child Labor, 1998). Development differences between adults and children may lead to distinct differences in risk perception and risk–taking activities while working in agriculture. Only a few studies have examined risk perception differences between adolescents and adults (Arnett, 2000; Cohn et al., 1995), and to our knowledge there are no published reports of risk perceptions among adolescent farmworkers.

Limited information is available on pesticide knowledge and risk perceptions of adult migrant farmworkers. Austin et al. (2001) reported on adult farmworker perceptions of control over avoiding the harmful effects of pesticides. Comparisons between farmer and farmworker beliefs and knowledge of chemical exposure have been explored (Quandt et al., 1998). Several studies by Vaughan (1993a, 1993b, 1995a, 1995b) explored the cultural context of work in the adult migrant farmworker population and beliefs about the hazards associated with that work.

The intent of this study is to expand on this previous work and begin exploring adolescent farmworker risk perceptions, pesticide knowledge, and cultural or developmental factors in the use of protection. The specific goals of this article are to:

1. Evaluate self–reported work practices, pesticide risk perceptions, and knowledge of pesticide hazards in a convenience sample of adolescent Latino migrant farmworkers.
2. Determine if certain demographic characteristics are associated with knowledge of hazards associated with pesticide exposure.
3. Examine the influence of pesticide knowledge and health beliefs on reported work practices such as wearing protective clothing.

We also propose the need for conceptual models to better understand the health behaviors of this understudied adolescent population.

Design and Methods

Design

This research was carried out as part of a community–based participatory research project in conjunction with a well–established community organization that places a strong programmatic emphasis on educational activities with migrant farmworker populations. The Oregon Migrant Education Program (MEP) offers secondary education and English as a second language (ESL) classes to adolescent farmworkers and children of migrant farmworkers. Members of this community worked jointly with university researchers in the design and conduct of the research.

Setting and Sampling

A cross–sectional survey of 102 migrant Latino adolescent farmworkers was conducted in Washington County, Oregon, where the primary crops are berries, nursery plants, and vegetables. These crops have high to moderate field–worker exposure, often involve heavy use of organophosphate pesticides, and are labor intensive (Nigg et al., 1992). The adolescent farmworkers, ages 13 to 18 and residing in migrant labor camps in Washington County, were recruited in collaboration with MEP. Adolescents were invited to participate in the research study if they were engaged in agricultural work. At the same time, MEP staff recruited these adolescents for their evening ESL program. Interviews took place at MEP facilities.

Human Subjects

The Oregon Health and Science University Committee for the Protection of Human Subjects approved all survey instruments. Adolescents traveling and working in the U.S. unaccompanied by either of their parents signed their own consent. Written parental consent and oral child assent were obtained from adolescent workers who were traveling with at least one of their parents.

Data Collection Instruments

The **Pesticide Knowledge Test** of 20 true–false items was developed by the research team to test basic knowledge among farmworkers. The items were chosen from content included in the U.S. EPA Worker Protection Standard training for farmworkers and measured knowledge in three general areas: general knowledge of pesticides, health problems associated with pesticide exposure, and protective clothing/safety. A total score was assessed for each respondent based on the number of correct answers given.

Content validity was determined by choosing questions that intentionally reflected knowledge contained in standard courses on pesticide use and safety. Face validity was obtained by having experts in farmworker health education review and approve the questionnaire items. While the short nature of the test made it culturally appropriate for administration to non–literate migrant farmworkers, it resulted in too few items to yield meaningful results on standard psychometric tests for reliability, such as the Kuder–Richardson 20. Analysis of the responses of participants showed that each individual question was positively associated with the total test scores, demonstrating internal consistency among the items.

The **Agricultural Work Practices Survey** contains items soliciting information on type of work (thinning, picking, etc.), type of crop(s), hours per week worked in agriculture, use of insect repellents, use of protective clothing, showering and laundry practices, work shoe removal, and wearing of work clothing outside of fields.

There are no published scales designed to measure health beliefs regarding pesticide exposure in farmworker populations. The **Farmworker Health Beliefs Survey**, adapted from an instrument previously used with adult migrant farmworkers (Vaughan, 1993a, 1995b), was used to measure beliefs. It contains 24 items to determine judgments of perceived harm from pesticide exposure.

Members of the Latino farmworker community assisted in the development of each of these study instruments. To increase the cultural appropriateness of these instruments, we conducted a multi–step translation and interpretation process for all consent forms and questionnaires. All questionnaires were pre–tested with Latino adolescents prior to their use. Questionnaires were administered by personal interviews with trained bilingual (English–Spanish) research staff.

Statistical Analysis

Adolescents' responses to the questionnaires were tabulated and described. The responses involving categorical data were compared using chi–square tests of association. In instances of prohibitively small cell counts, a simulated version of Fisher's exact test was performed (Manly, 1997). Analysis of variance and regression were used to investigate how the knowledge score was influenced by variables such as age, beliefs, amount of agricultural training, and level of agricultural experience. Logistic regression was used to investigate how the odds of using protection are affected by belief and knowledge variables.

Results

The mean age of the adolescent farmworkers participating in the study was 16.3 years ($\pm$1.5) and the sample was primarily male (92.2%) (see table 1). Many of the adolescents (64.7%) were traveling and working in the U.S. independent of their parents. Ninety–six of 102 adolescents reported Mexico as their native country. All of the adolescents spoke Spanish as either their first or second language, and 36.3% of the adolescent participants spoke primarily indigenous languages. The Mixteco, Trique, and Kanjobal dialects were most common. The adolescents speaking an indigenous language all spoke Spanish as a second language. Only 5.9% of the sample spoke English as a second language.

The adolescents were primarily field crop workers (91.2%). Among the group, 21.6% reported that in their current job they mixed and/or applied pesticides, herbicides, fungicides, or other chemicals. An additional 12 adolescents reported that their previous work involved mixing/applying these chemicals. Of the 22 adolescents who reported that their current work involved these activities, 38.1% indicated that they mixed or applied these chemicals daily or once a week. Eight of these 22 adolescents were age 15 or younger, with the remainder between ages 16 and 18. The younger adolescents were less likely to report frequent mixing/applying of these chemicals (two of the eight younger adolescents compared to six of the 14 older

adolescents). Of the 22 adolescents, 15 were traveling and working in the U.S. without their parents.

Only 32.4% of the adolescent farmworkers reported that they had received prior pesticide safety training. Among the 22 adolescents reporting current mixing/applying chemicals, eight (36.4%) reported having received prior pesticide training.

Study participants were asked several questions about end–of–work practices. Seventy–three percent of the adolescents reported that they changed from their work clothes at work or within 30 minutes of arriving home. A similar proportion of adolescents reported they always remove their footwear before entering the home. Most of the participants reported showering within an hour of arriving home.

Fifty percent of the adolescents reported that they always or sometimes wore or used protective clothing/equipment when working. These participants were asked to indicate from a list of protective clothing/equipment those that they used. Table 2 shows that the most frequent types of protective clothing reported by adolescents were long pants, long–sleeved shirts, and caps or hats. Adolescents who reported that they currently mixed/applied agricultural chemicals reported higher use of rubber boots, overalls, goggles/glasses, rubber gloves, and plastic clothes than adolescents who did not report this work activity.

Table 1. Demographic characteristics of the adolescent farmworkers (N = 102).

Demographic Characteristics		N	%
Mean age	16.3 ±1.5 years	—	—
Gender	Female	8	7.8
	Male	94	92.2
Country of origin	Mexico	96	94.1
	Guatemala or Nicaragua	6	5.9
Primary language	Spanish	65	63.7
	Indigenous dialect	37	36.3
English as a second language	Yes	6	5.9
	No	96	94.1
Education	With any U.S. education	16	15.7
	No U.S. education	86	84.3

Table 2. Self–reported use of protective clothing/equipment by 51 adolescent migrant farmworkers.

Protective Clothing/Equipment	Adolescents Reporting Use (%)
Long–sleeved shirt	98.0
Long pants	100.0
Rubber boots	85.7
Cap/helmet/hat	98.0
Overalls	44.9
Goggles/glasses	43.8
Rubber/cloth gloves	83.7
Handkerchief over nose and mouth	54.2
Plastic clothes	47.9

Health Beliefs

Eighty–six percent of the adolescents reported that it would be difficult to impossible to find a job outside of agriculture (table 3). A large proportion (42.2%) reported the belief that they were never exposed to pesticides in their work, and 40.2% reported that there are no ways to protect oneself from pesticides. However, the large majority (79.4%) reported that pesticides could cause health problems, and over half reported they had fears about these health effects. Almost half of the sample (44.5%) reported the belief that they have some concern that they have become sick from being around pesticides. When adolescents were asked if they believed that a teenager working in the field would experience some health problems in the future, 81.4% reported that it was somewhat to definitely likely. However, 74.3% of these youth reported that there was a somewhat to definite chance that they personally would experience any health problem in the future.

Table 3. Adolescent farmworker beliefs about farm work, pesticide exposure, and health.

	Adolescent Workers (N = 102)	
Health Belief Questions and Responses	N	%
How difficult do you think it would be to find a job outside of agriculture?[a]		
A little to impossible	80	86.0
Not difficult	13	14.0
Are you exposed to pesticides while working in the fields?		
Daily/once a week/once in a while	59	57.8
Never	43	42.2
Are there ways to protect yourself from exposure to pesticides?		
Yes	61	59.8
No	41	40.2
Do you think pesticides can cause health problems?		
Yes	81	79.4
No or not sure	21	20.6
How often in the past month have you had fears about health effects of pesticides?		
Never	49	48.0
Daily/once a month/once a week	53	52.0
Do you believe that you have become sick from being around pesticides?[a]		
Yes, enough to worry a great deal	17	16.8
Yes, enough to cause a little or no concern	28	27.7
Not at all	56	55.4
Do you believe that pesticides can affect the health of children born to farmworkers?		
Yes, enough to worry a great deal	42	41.1
Yes, enough to cause a little or no concern	35	34.3
Not at all	25	24.5
What are the chances that a [teenager] or [farmworker] working in the field will experience some health problems in the future?		
Definitely to somewhat likely	83	81.4
No chance	19	18.6
What are the chances that you will experience health problems in the future?[a]		
Definitely to somewhat likely	75	74.3
No chance	26	25.7

[a] Missing values; not all adolescents answered questions.

Knowledge Scores

Factors such as gender, age, past pesticide training, years of education in country of origin, any U.S. education, and primary language or speaking English as a second language were examined for association with the percent of correct responses on the pesticide knowledge test. The final statistical model (shown in table 4) involved primary language and prior pesticide training. After adjusting for whether an individual reported training, average scores for study participants who spoke indigenous dialects were approximately seven percentage points lower than for those who spoke Spanish as their primary language (95% CI, 2–11).

Table 4. Model for estimating the mean percent correct on the pesticide knowledge questionnaire in a sample of adolescent farmworkers.

Explanatory Variable	Regression Coefficient	95% CI
Intercept	0.75	
Indigenous dialect	–0.07	(–0.11, –0.02)
Past pesticide training	0.04	(–0.01, 0.09)

$R^2 = 9.6\%$
$F(2, 99) = 5.231, p < 0.001$

Predictors for the Use of Protection

Analyses were performed to determine the factors most likely to be predictive of a positive response to the question: "Do you use any protection against exposure to pesticides?" Background characteristics, health beliefs, and knowledge scores were entered into the modeling procedures. A logistic regression model involving beliefs and knowledge variables was found through backwards elimination using the Bayesian Information Criterion (Raftery and Volinsky, 1996). Knowledge score was the most significant predictor of using protection methods (table 5). The odds of using protective methods increased 1.39 times for each additional correct answer given on the pesticide knowledge test (95% CI, 1.13–1.71). Having received prior training about pesticides was significantly associated with using protection, although the variation was considerable (OR = 9.66, 95% CI, 1.14–82.19). Perception and belief variables were not significantly associated with reported use of protection among adolescent workers (p–value = 0.26).

Table 5. Logistic regression model for estimating the odds of adolescent farmworkers using protection as a function of pesticide knowledge and having received prior information.

Explanatory Variable	Regression Coefficient	OR	95% CI
Intercept	–6.99		
Number correct on knowledge test	0.33	1.39	(1.13, 1.71)
Received prior pesticide information	2.27	9.66	(1.14, 82.2)

$R^2 = 26.7\%$
$X_2^2 = 22.8, p < 0.01$

Discussion

Work Practices

A surprising finding in this study was that nearly a quarter of the adolescents answered affirmatively to the question "In your current job do you mix/apply pesticides, herbicides, fungicides, or other chemicals?" The validity of this response was reinforced by the finding that this subgroup of adolescents reported higher use of protective equipment/clothing than the other adolescents. Adolescents below the age of 16 are prohibited from handling or applying pesticides and other agricultural chemicals classified as Category I or II of toxicity by the Federal Insecticide, Fungicide, and Rodenticide Act (7 U.S.C. §136) (Committee on the Health and Safety Implications of Child Labor, 1998; U. S. Department of Labor, 1984).

Because these adolescents worked for multiple employers, it is impossible to determine what specific chemicals they may have been applying at the time of the survey. However, the majority of the adolescents were harvesting types of berry crops that are often sprayed with Category III pesticides malathion and diazinon shortly before harvest. Berry crops in Oregon are also sometimes sprayed with the fungicide captan (of the phthalimide family) 48 hours prior to harvest. Most fungicides are either poisonous or noxious and should be handled with care. Guidelines often include a caution to not permit children to have access to fungicides (DeAngelis et al., 2000).

It should be noted that the toxicity classification of pesticides is based on acute toxicity and LD_{50} levels and does not include a chemical's mutagenic and/or carcinogenic potential. Furthermore, given the low proportion of adolescents who have received pesticide training, it is unlikely that they understand the pesticide labels, warning, and toxicity classifications.

The frequency of chemical mixing/application among our adolescent sample was higher than expected and exceeds the frequency in adult groups that we have studied. In a survey conducted in 1997 of 97 adult farmworkers in Washington County and 69 adult farmworkers in Hood River County (McCauley et al., 2001), we found that 13.4% of the Washington County adults and 11.9% of the Hood River adults reported that their work included mixing or applying agricultural chemicals. Given this information, the rate of 21.6% in the adolescent sample was higher than expected, and more research on the actual work practices of adolescent farmworkers who report mixing or applying agricultural chemicals is indicated.

Pesticide Knowledge

Pesticide knowledge scores were associated with reports of using worker protection. Among the adolescents, participants whose primary language was an indigenous dialect were more likely to have lower knowledge scores. The migrant Latino farmworker population is a diverse community, and increasing numbers of new migrants entering the U.S. represent indigenous groups from the southern states of Mexico. Mixtec workers from the state of Oaxaca are perhaps the largest indigenous group working in western U.S. agriculture (Zabin et al., 1993) and represent approximately 5% to 10% of the agricultural workforce. Indigenous farmworkers, like the Mixtecos often encountered in Oregon, frequently speak little or no Spanish or English, are in more desperate economic circumstances, and have

cultural, language, and physical characteristics distinct from Spanish–speaking Latino individuals.

As the number of adolescent farmworkers increases in the U.S. and the characteristics of the migrant stream continue to change, adolescents from indigenous regions of Mexico will continue to be represented in the agricultural workforce. Although all of the study participants acknowledged speaking Spanish, it is impossible to discern from our data how much of the difference in pesticide knowledge scores was attributable to a lack of understanding of the question and how much was attributable to a lack of pesticide knowledge. Regardless, these findings support the need for education or training programs on health risks and protection methods to reduce pesticide exposure for all adolescent farmworkers and especially for those of indigenous heritage.

It has previously been noted that effective risk information for the minority farmworker population should be framed in culturally relevant terms (Christopher, 2001; Vaughan, 1993b). The success of an educational program may be determined not by what is taught but rather by how the information is relayed to maximize the perceived relevance of the subject. Our results indicate that such programs need to be customized to both the age and language of the farmworker. The EPA's Worker Protection Standard regulations (U.S. EPA, 1996) include provisions for training employees in agriculture but do not take into account the special risks to young workers. Studies are needed to assess the effectiveness of this regulation in protecting the health of minority adolescents working in agriculture.

Training Requirements and Recommendations for Protecting Workers from Pesticides

The frequency of having received pesticide training was low in our sample but not different from those reported by other investigators (Arcury et al., 2001). The Worker Protection Standard indicates that all workers must receive basic training at time of hire. This basic training includes an overview of the potential risks involved in fieldwork and how to protect oneself from these risks. In general, this basic training points out the information displayed on the EPA poster that is required to be posted in every agricultural workplace.

By the sixth day of employment, all workers must have the WPS training; in Oregon this is frequently offered as a video or a flip chart presentation. The WPS training requirements for workers must be in effect from the time that a pesticide is applied until 30 days after the expiration of the final restrictive entry interval (REI). This applies to all pesticides, including fungicides, which have the WPS regulation cited on the label.

All states must, at a minimum, meet the requirements of the federal WPS, but some states may be more restrictive. The WPS worker training does not have to be effective (i.e., workers must receive the information, but they do not have to *know* the information). Theoretically, it is possible that a worker would not need WPS training. This would be possible if the worker was working in a field 30 days after termination of the REI. However, in the farming practices in our region, this condition is not likely.

In addition to federal regulations, the state of Oregon requires that all agricultural workers receive "hazard communication" (OAR 437–004–9800). While pesticide handlers receive extensive hazard communication because they may be in direct

contact with pesticides, workers receive basic hazard communication because they may be in contact with pesticide residues. In Oregon, giving workers the brochure titled, "Safe Practices When Working Around Hazardous Agricultural Chemicals," published by Oregon OSHA, fulfills the communication requirement. This brochure is printed in both English and Spanish.

The WPS–certified training materials, such as the EPA flipchart and booklet (U.S. EPA, 1993) teach the importance of wearing clean, skin–covering clothes to work each day. This includes long pants, a long–sleeved shirt, and shoes and socks. Although the purpose of this article is not to judge the appropriateness of the WPS materials, it is interesting to point out the manner in which the concept of pesticides is presented in the WPS materials. While there are numerous references to pesticides and to the forms and modes in which one can be exposed, there is little mention of pesticide *residues*. Pesticide residues have been found on and around crops well after the REI has passed and workers are allowed into the field (Bradman et al., 1997; Lu et al., 2000; McCauley et al., 2001; Simcox et al., 1995; Simcox et al., 1999).

The training material indicates that pesticides are applied as liquids, sprays, powders, granules, or gases. It also indicates that pesticides may be on plants and in the soil and often one cannot tell if pesticides are present. While the training materials warn of pesticides in irrigation water and contact by drift, there is little suggestion of pesticides being a daily hazard because of contact with pesticide residues. Most of the illustrations and commentary pertain to direct contact with pesticides, such as what to do if a pesticide is splashed in the eye, swallowed, or spilled directly on the skin. This could influence farmworkers' use of protective clothing: if they do not perceive a daily risk from pesticide residues, then they may not perceive a need to protect themselves. Future studies should examine farmworkers' perceptions of pesticides as a tangible chemical substance or as an often–undetectable residue that may not be considered hazardous when there is no perception of material contact.

Health Beliefs

The health beliefs reported by these adolescents point to areas of significant concern that perhaps reflect the developmental level of youth workers and indicate the need for special educational efforts. Our finding that beliefs are not associated with using protective clothing/equipment could be caused by a lack of a direct association between one's health beliefs and behavioral outcomes.

The results of this study point to a degree of optimistic bias in the adolescent sample. Several studies have examined optimistic bias and health behavior of multicultural populations (Price et al., 1988; Turner and Kiecolt, 1984) and risk perceptions of Latino adolescents in general (Parker et al., 1998; Strunin, 1991). However, the attitudes of adolescent migrant farmworkers may be very different from other Latino adolescents in the U.S. Vaughan has studied male adult farmworkers working in California and found evidence of optimistic bias (Vaughan, 1993a, 1995b). It is unknown to what extent the optimistic bias observed in our adolescent sample is related to their developmental stage or perhaps to unmeasured cultural attributes.

Limitations

Recruiting farmworkers through community partners like MEP does not offer a representative sample of the adolescent farmworker population as a whole. These adolescents may be more ambitious and place a higher value on education. As a result, our sample may have scored higher on the knowledge test and may have been more aware of health and safety precautions than the general adolescent migrant farmworker population.

This study is also limited by the regional scope of the research. However, this sample of Oregon farmworkers shares characteristics, such as health beliefs and work practices, reported by farmworkers in other U.S. agricultural regions. For example, 49% of California subjects (Vaughan, 1995b) and 48% of North Carolina subjects (Austin et al., 2001) reported using protection against pesticide exposure (compared to our 50%).

Future Plans

While the factors explored to date provide valuable information on the health behaviors of an under–studied population, they do not adequately explain the determinants of work practices and beliefs in the adolescent farmworker population. We are currently utilizing an ecological model and focus group methodology to explore adolescent farmworkers' beliefs and attitudes about the health hazards associated with exposures to pesticides and the use of protective clothing and practices. These adolescent farmworkers' beliefs about particular salient individuals, such as the boss, co–workers, and friends, have proven to be a common theme in regard to motivators for use of protective clothing and behaviors (Salazar et al., 2002).

In addition, we are investigating farmworkers' perception of protective clothing and their motivation to comply with protective actions. To gain a deeper appreciation of the perspective of seasonal migratory workers, the value and meaning of agricultural work in this population is also being explored. This information will be integrated into current study instruments that we are using with migrant farmworkers in order to more fully understand the work characteristics and occupational risks of youth agricultural workers.

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References

Arcury, T., S. Quandt, A. Cravey, R. Elmore, and G. Russell. 2001. Farmworker reports of pesticide safety and sanitation in the work environment. *American J. Industrial Medicine* 39(5): 487–498.

Arnett, J. 2000. Optimistic bias in adolescent and adult smokers and nonsmokers. *Addictive Behaviors* 25(4): 625–632.

Austin, C., T. Arcury, S. Quandt, J. Preisser, R. Saavedra, and L. Cabrera. 2001. Training farmworkers about pesticide safety: Issues of control. *J. Health Care for the Poor and Underserved* 12(2): 236–249.

Bradman, M., M. Harnly, W. Draper, S. Seidel, S. Teran, D. Wakeham, and R. Neutra. 1997. Pesticide exposures to children from California's Central Valley: Results of a pilot study. *J. Exposure Analysis and Environmental Epidemiology* 7(2): 217–234.

Christopher, B. 2001. Health and safety training for the growing Hispanic workforce. Presentation at National Safety Council Congress in Atlanta, Ga. Alice Hamilton Occupational Health Center.

Cohn, L., S. Macfarlane, C. Yanez, and W. Imai. 1995. Risk–perception: Differences between adolescents and adults. *Health Psychology* 14(3): 217–222.

Committee on the Health and Safety Implications of Child Labor. 1998. *Protecting Youth at Work: Health, Safety, and Development of Working Children and Adolescents in the United States*. Washington, D.C.: National Academy Press.

DeAngelis, J., A. J. Dreves, T. Miller, F. Niederholzer, J. Olsen, M. Shenk, P. VanBuskirk, C. Baird, J. Barbour, L. Sandvol, A. Antonelli. 2000. *Pacific Northwest 2000 Insect Management Handbook*. Corvallis, Ore.: Oregon State University.

Golub, M. 2000. Adolescent health and the environment. *Environmental Health Perspectives* 108(4): 355–362.

Kissam, E., A. Garcia, D. Griffith, M. Heppel, L. Tores, N. Mullenax, A. Flores, A. Rodriguez, V. Barrat, and J. Thomas. 2001. *No Longer Children: Case Studies of the Living and Working Conditions of the Youth who Harvest America's Crops*. San Mateo, Cal.: Aguirre International.

Lu, C., R. Fenske, N. Simcox, and D. Kalman. 2000. Pesticide exposure of children in an agricultural community: Evidence of household proximity to farmland and take–home exposure pathways. *Environmental Research* 84(3): 290–302.

Manly, B. F. J. 1997. *Randomization, Bootstrap, and Monte Carlo Methods in Biology*. New York, N.Y.: Chapman and Hall.

McCauley, L., M. Lasarev, G. Higgins, J. Rothlein, J. Muniz, C. Ebbert, and J. Phillips. 2001. Work characteristics and pesticide exposures among migrant agricultural families: A community–based research approach. *Environmental Health Perspectives* 109(5): 533–538.

Nigg, H., R. Beier, O. Carter, C. Chaisson, C. Franklin, T. Lavy, R. Lewis, P. Lombardo, J. McCarthy, K. Maddy, M. Moses, D. Norris, C. Peck, K. Skinner, and R. Tardiff. 1992. Exposure to pesticides. In *The Effects of Pesticides on Human Health*, 35–129. Princeton, N.J.: Princeton Scientific Publishing.

NRDC. 1998. Children in the fields. Chapter 3 in *Trouble on the Farm: Growing Up with Pesticides in Agricultural Communities*. New York, N.Y.: Natural Resources Defense Council.

Parker, V., S. Sussman, D. Crippens, P. Elder, and D. Scholl. 1998. The relationship of ethnic identification with cigarette smoking among U.S. urban African–American and Latino youth: A pilot study. *Ethnicity and Health* 3(1–2): 135–43.

Price, J., S. Desmond, M. Wallace, D. Smith, and P. Steward. 1988. Differences in black and white adolescents' perceptions about cancer. *J. School Health* 58(2): 66–70.

Quandt, S., T. Arcury, C. Austin, and R. Saavedra. 1998. Farmworker and farmer perceptions of farmworker agricultural chemical exposure in North Carolina. *Human Organization* 57(3): 359–368.

Quandt, S., C. Austin, T. Arcury, M. Summers, and R. Saavedra. 1999. Agricultural chemical safety training materials for farmworkers: Review and annotated bibliography. *J. Agromedicine* 6(1): 3–24.

Raftery, A., and C. Volinsky. 1996. S–PLUS function to apply Baysian Model averaging to variable selection for logistic regression. Available at: http://lib.stat.cmu.edu/S/bic.logit.

Salazar, M. K., M. Napolitano, J. A. Scherer, and L. A. McCauley. 2002. Adolescent farmworkers' perceptions of health risks associated with pesticides exposure. In review. Presented as: Integration of research, education, and community involvement of adolescents working in agriculture. National EPA Community Involvement Conference. June 2002. Portland, Ore.

Shu, X. O., Y. T. Gao, L. A. Brinton, M. S. Linet, J. T. Tu, W. Zheng, and J. F. Fraumeni, Jr. 1988. A population–based case–control study of childhood leukemia in Shanghai. *Cancer* 62(3): 635–644.

Simcox, N., R. Fenske, S. Wolz, I. Lee, and D. Kalman. 1995. Pesticides in household dust and soil: Exposure pathways for children of agricultural families. *Environmental Health Perspectives* 103(12): 1126–1134.

Simcox, N., C. Camp, D. Kalman, A. Stebbins, G. Bellamy, I. Lee, and R. Fenske. 1999. Farmworker exposure to organophosphorus pesticide residues during apple thinning in Central Washington State. *American Industrial Hygiene Association J*. 60(6): 752–761.

Strunin, L. 1991. Adolescents' perceptions of risk for HIV infection: Implications for future research. *Social Science and Medicine* 32(2): 221–228.

Turner, R., and K. Kiecolt. 1984. Responses to uncertainty and risk: Mexican–American, black, and Anglo beliefs about the manageability of the future. *Social Science Quarterly* 65(3): 665–679.

U.S. Department of Labor. 1984. Child labor requirements in agriculture under the Fair Labor Standards Act (Child Labor Bulletin No. 102). WH Publication No. 1295. Washington, D.C.: U.S. Department of Labor.

_____. 2000. Findings from the National Agricultural Workers Survey (NAWS) 1997–1998: A demographic and employment profile of United States farmworkers. Washington, D.C.: Department of Labor.

U.S. EPA. 1993. Protect yourself from pesticides: Guide for agricultural workers. GPO 055–000–00443–9. Washington, D.C.: U.S. Environmental Protection Agency.

_____. 1996. Part 170: Worker Protection Standard. 40 CFR Part 170. Washington, D.C.: U.S. Environmental Protection Agency. Available at: www.epa.gov/pesticides/safety/workers/PART170.htm.

U.S. GAO. 1998a. Child labor in agriculture: Changes needed to better protect health and educational opportunities. GAO/HEHS–98–193. Washington, D.C.: U.S. General Accounting Office.

_____. 1998b. Child labor in agriculture: Characteristics and legality of work. GAO/HEHS–98–112R. Washington, D.C.: U.S. General Accounting Office.

Vaughan, E. 1993a. Chronic exposure to an environmental hazard: Risk perceptions and self–protective behavior. *Health Psychology* 12(1): 74–85.

_____. 1993b. Individual and cultural differences in adaptation to environmental risks. *American Psychology* 48(6): 673–680.

_____. 1995a. The significance of socioeconomic and ethnic diversity for the risk communication process. *Risk Analysis* 15(2): 169–180.

_____. 1995b. The socioeconomic context of exposure and response to environmental risk. *Environment and Behavior* 27(4): 454–489.

Zabin, C., M. Kearney, A. Garcia, D. Runsten, and C. Nagengast. 1993. *Mixtec Migrants in California Agriculture: A New Cycle of Poverty.* Davis, Cal.: California Institute for Rural Studies.